Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

CSAS | **SCCS**

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Research Document 2002/003 | **Document de recherche 2002/003**

Not to be cited without permission of the authors * | Ne pas citer sans autorisation des auteurs *

Exploitation rates and movements of Atlantic cod *(Gadus morhua)* in NAFO Subdiv. 3Ps based on tagging experiments conducted during 1997-2001

Taux d'exploitation et mouvements de la morue de l'Atlantique *(Gadus morhua)* dans la sous-divison 3Ps déterminés à partir d'expériences de marquage réalisées de 1997 à 2001

J. Brattey, D. R. Porter, and C. W. George

Science, Oceans and Environment Branch
Department of Fisheries and Oceans
Box 5667, St. John's, NF Canada
A1C 5X1

* This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

This document is available on the Internet at:

* La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au Secrétariat.

Ce document est disponible sur l'Internet à:

http://www.dfo-mpo.gc.ca/csas/

ISSN 1480-4883
© Her Majesty the Queen in Right of Canada, 2002
© Sa majesté la Reine, Chef du Canada, 2002

Canada

Abstract

A large-scale mark-recapture study of adult (>45 cm) Atlantic cod (*Gadus morhua*), initiated in 3Ps in spring 1997, was continued. During 1997-2001 a total of 42,000 live cod were tagged with single, double, or high-reward t-bar anchor tags and released at various inshore and offshore locations off the south coast of Newfoundland. Approximately 6,500 tagged cod have been reported as recaptured up to September 2001. Tag returns were adjusted to account for region-specific reporting rates, and the number of tagged cod available for capture was adjusted to account for tagging mortality, tag loss and assumed natural mortality. These data were used to estimate annual exploitation rates for each batch of tagged cod. The spatial distribution of recaptures from tagging in each area was summarized annually with numbers recaptured adjusted to account for region-specific reporting rates. Cod tagged offshore were often recaptured considerable distances from the tagging area; those tagged on Burgeo Bank moved into 3Pn-4RS or eastward along the inshore of 3Ps and the proportions in each region differed considerably between years. Those tagged in Halibut Channel remained offshore or migrated inshore to Placentia Bay and the Avalon Peninsula. Cod tagged inshore in Placentia Bay were mostly recaptured within Placentia Bay, but small proportions (~5%) were also recaptured in southern 3L, Fortune Bay, or in offshore 3Ps. Cod tagged in Fortune Bay were mostly recaptured inshore in Fortune Bay or Placentia Bay, or more rarely westward into Hermitage Bay. Exploitation rates estimated from tag returns differed markedly across the stock area. Annual estimates of exploitation for cod tagged offshore in Halibut Channel in three consecutive years (1998-2000) were consistently low (0-0.06), as were those for cod tagged offshore in the Burgeo Bank-Hermitage Channel area (0.05-0.13). Exploitation of cod tagged in Fortune Bay ranged from 0.11 to 0.22. Estimates of exploitation rate for cod tagged in Placentia Bay have been much higher, with many estimates exceeding 0.30 in both 1999 and 2000; results from the tagging analyses indicate that measures are required to lower the exploitation rate in this portion of the stock area.

Résumé

Une étude de marquage-recapture à grande échelle de la morue de l'Atlantique (Gadus morhua) adulte (>45 cm) lancée au printemps de 1997 s'est poursuivie. De 1997 à 2001, un total de 42 000 morues vivantes ont été marquées au moyen d'étiquettes à ancrage en T à récompenses simples, doubles ou élevées avant d'être remises à l'eau à divers endroits dans les eaux côtières et hauturières au sud de Terre-Neuve. En septembre 2001, on avait signalé la recapture d'environ 6 500 morues marquées. Nous avons corrigé les nombres de recaptures en fonction du taux de déclaration propre à la région et nous avons corrigé le nombre de morues marquées disponibles à la pêche pour tenir compte de la mortalité due au marquage, des étiquettes perdues et de la mortalité naturelle présumée. Ces données ont ensuite servi à estimer les taux d'exploitation annuels de chaque lot de morues marquées. Nous avons résumé les répartitions spatiales annuelles des recaptures dans chaque région en corrigeant les nombres selon le taux de déclaration propre à chaque région. Des morues marquées en haute mer étaient souvent recapturées à de grandes distances de l'endroit où on leur avait posé une étiquette; les morues marquées au banc Burgeo se sont déplacées dans 3Pn-4RS ou vers l'est le long de la côte dans 3Ps, et les proportions dans chaque région variaient beaucoup d'une année à l'autre. Les morues marquées dans le chenal du Flétan sont restées en haute mer ou ont migré vers la côte, dans la baie Placentia et près de la presqu'île Avalon. Les morues marquées dans les eaux côtières de la baie Placentia ont surtout été recapturées dans la baie, mais une petite proportion (~5 %) a été recapturée dans la partie sud de 3L, dans la baie Fortune, ou dans la partie hauturière de 3Ps. Les morues marquées dans la baie Fortune ont surtout été recapturées dans les eaux côtières des baies Fortune ou Placentia ou, plus rarement vers l'ouest, dans la baie Hermitage. Les taux d'exploitation estimés à partir des recaptures variaient considérablement dans la zone de stock. Pendant trois années consécutives (de 1998 à 2000), les estimations du taux d'exploitation annuel pour les morues marquées dans les eaux hauturières du chenal du Flétan étaient toujours basses (de 0 à 0,06), comme pour les morues marquées dans les eaux hauturières du secteur banc Burgeo-chenal Hermitage (de 0,05 à 0,13). Le taux d'exploitation pour la morue marquée dans la baie Fortune variait de 0,11 à 0,22. Les estimations du taux d'exploitation pour les morues marquées dans la baie Placentia étaient beaucoup plus élevées, bon nombre d'estimations dépassant 0,30 en 1999 et en 2000; les résultats des analyses de marquage indiquent qu'il faut prendre des mesures pour réduire le taux d'exploitation dans cette partie de la zone de stock.

Introduction

A mark-recapture study of Atlantic cod (*Gadus morhua*) initiated in NAFO Subdiv. 3Ps during 1997 was continued in 2001. The purpose of the study was to provide information on movement patterns of inshore and offshore cod as well as obtain estimates of exploitation rates on different components of the stock.

In this study, annual estimates of exploitation are given for each tagging experiment conducted in 3Ps during 1997-2001 using the methods described in Brattey et al. (2001). This document also gives (1) a synopsis of the spatial and temporal distribution of recaptures of tagged cod released in various regions of Subdiv. 3Ps during 1997-2001 and reported as recaptured up to the end of September 2001, and (2) illustrates the distribution of recaptures from tagging conducted in 2000 and 2001. Information on stock structure and seasonal movement patterns from other post-moratorium cod tagging studies is reported in previous documents (Lawson et al. 1998; Brattey 1999, 2000; Brattey et al. 1999). Historical cod tagging studies (prior to 1994) in the Newfoundland Region are summarized in Taggart et al. (1995), Myers et al. (1996, 1997). Further analyses of the data from the current experiments are presented elsewhere (Cadigan and Brattey 1999a, b; 2000a, b; Lilly et al. 2001; Pope and Brattey 2001).

Materials and Methods

Cod for tagging were captured with various gears (mostly hand-line in the inshore and otter trawl in the offshore), measured (nearest cm) and tagged with one or two t-bar anchor tags inserted at the base of the first dorsal fin, and released. Experienced technicians conducted the tagging. Only cod ≥45 cm (fork length) that appeared healthy were tagged and each batch of cod typically consisted of individuals tagged with either single, double, or high–reward tags. The tags were uniquely numbered and bore a return address as well as the value of the reward ($10 for one single, $20 for two singles, or $100 for high-reward). The tagging program was advertised extensively among those participating in the fishery. Details of the tagging experiments are summarized in Table 1. The number of cod tagged each year ranged from 6,022 in 1997 to 9,770 in 2000. Tagging was mostly conducted in early spring on spawning and pre-spawning aggregations in several areas, inner Placentia Bay, Halibut Channel, Burgeo-Bank -Hermitage Channel, and at two locations in Fortune Bay (Poole Cove and Pass Island)(Fig. 1). Some cod were also tagged in fall (October-November) in Placentia Bay and on the northwestern corner of St. Pierre Bank in spring 2001. The sizes of tagged cod ranged from 45 to about 115 cm with mean lengths mostly in the 55-65 cm range.

Reported landings of cod from 3Ps during the period 1997 to early October 2001 were extracted from the Statistics Branch catch database and are summarized to aid in the interpretation of tag returns.

Estimation of exploitation rates

The methods used to estimate exploitation rates are described in Brattey et al. (2001). The number of reported recaptures from individual cod tagging experiments gives minimum estimates of the exploitation rates on the aggregations of cod that were tagged. However, in practice, not all fish survive tagging, some tags fall of the fish particularly in the first year, and not all recaptures of tagged fish are reported. Tagged (and untagged) cod also suffer natural mortality due to factors such as predation and disease. Accounting for these losses leads to a reduction in the number of tagged (and untagged) animals available to the fishery. We used information from companion studies to estimate these losses and produce more realistic annual estimates of exploitation. In this analysis we estimated exploitation rates for cod tagged in a specific area at a specific time (i.e. individual tagging experiments), irrespective of where recaptures came from. Only releases (M) in 3Ps in 1997-2001 were used in this analysis. We did not attempt to estimate population sizes using tag returns and commercial catches in this analysis, because typically some harvesting occurs in an area different from where fish were tagged; this makes it difficult to convert local catches to local population biomass. Analyses of the tagging data that include methods to estimate inshore cod biomass are presented elsewhere (Lilly et al. 2001; Pope and Brattey 2001; Cadigan and Brattey 2001).

We estimated tag-induced mortality ($\mathcal{J}$) by retaining tagged cod in submersible cages for periods of 5-10 days and monitoring their survival (Brattey and Cadigan 2001). An estimate of 0.13 was obtained from these studies and this value was used for all experiments (i.e. $1-\mathcal{J}=0.87$ survived tagging).

Our method of estimating reporting rate (δ) is based on a high-reward tagging study, described in detail in Cadigan and Brattey (1999a, 2000b) and updated with recent recaptures. We used region-specific estimates of reporting rate calculated from the high-reward at tagging study; high-reward tags (k=3) were assumed to have a reporting rate of 1.0.

Tag loss rates were estimated from a double-tagging study (see Cadigan and Brattey 1999a), which showed that tag loss mostly occurred in the first 3-4 months after release with only minimal losses thereafter. For simplicity, we assumed that tag loss (λ) occurred only in the year of release (y_0) and was negligible thereafter. Rather than the more complex non-parametric tag loss model of Cadigan and Brattey (1999a), we used a simple proportional tag loss model where the tag loss rate for single and high reward tags was $\lambda<=0.8^{(52/diff_y0)}$ and for double tags $\lambda<=0.96^{(52/diff_y0)}$, where $diff_y_0$ = the number of weeks between the median date of release of tagged fish and the median recapture date of tagged individuals in the year of release. If there were no recaptures in the year of release then $diff_y_0$ was set to one half the number of weeks between the median week of release and the end of the year. This gives a reasonable approximation for tag loss rates.

The instantaneous rate of natural mortality was assumed to be 0.2 per yr, and occurred during $diff_y_0$ in the year of release, and between the median dates of recapture between y_0 and y_1. Note that some tagged fish were released during the fishery and annual exploitation estimates for these releases only account for exploitation during a portion of the year. Assuming that M fish are

tagged and released with tags of type k and that tag loss and natural mortality take place between the median date of release and recapture, the exploitation rate in the year of release ($:_0$) is:

$$:_0 = E_k(R_{0k}/\delta_k)/((1-\mathcal{J})M_k\, e^{-m(52/diff)} <_k^{(52/diff)})$$

and in the second year ($:_1$) after release:

$$:_1 = E_k(R_{1k}/\delta_k)/((1-:_0)M_k\, e^{-m(52/diff)})$$

For some areas several tagging experiments were conducted in successive years and we also computed pooled estimates of exploitation (typically by unit area, i.e. 3Psc, 3Psh) simply by calculating the mean of the individual estimates, weighted by the estimated number of releases available for recapture.

Results

Spatial and temporal distribution of cod landings

The total allowable catches (TAC's) in 3Ps in the post-moratorium period were: 10,000 t in 1997, 20,000 t in 1998, 30,000 t in 1999, an interim TAC of 6,000 t during January-March 2000, 20,000 t during 1 April 2000 to 31 March 2001, and 15,000 t during 1 April 2001- 31 March 2002. The spatial patterns in landings were broadly similar each year with highest landings (30-50% of the entire TAC) coming from Placentia Bay (see Brattey et al. 2001). Reported monthly landings by unit area for 2000 and the first nine months of 2001 are summarized in Table 2. There were substantial landings (>1,000 t) in all unit areas, except 3Psd (248.9 t) which is closed to directed cod fishing from November 15 – April 15, and 3Psg (155.8 t). There were substantial inshore landings in first three months of 2000 in 3Psc and to a lesser extent 3Psa and 3Psb. Inshore landings in April and May were low and came mostly from by-catch fisheries. There were substantial landings in all inshore unit areas during June and July 2000, particularly in Placentia Bay with reported landings of over 2,400 t. Landings from inshore areas were low in August 2000, but increased in September and in November. As in previous years, there were substantial landings (2,412 t) in Placentia Bay during November. In the offshore, landings tended to be higher in fall and winter and low during the summer months (June-August), with Halibut Channel and the southeastern corner of St. Pierre Bank accounting for most of the offshore landings. Preliminary landings for the 2001 calendar year show similar spatial and temporal trends to those seen in 2000, but with less inshore catch during the first three months.

Numbers of recaptures

Details of the numbers of tagged cod reported as recaptured annually up to the end of September 2001 are summarized in Table 3. There have been substantial numbers of recaptures from most tagging experiments, particularly those conducted in Placentia Bay during spring. For the 1997 releases, there have been many recaptures from four consecutive years of commercial fishery 1997-2000), although the numbers of recaptures from the fifth year (2001) appears to have

diminished considerably. Offshore taggings (Halibut Channel, Hermitage Channel, Burgeo Bank) have tended to generate substantially fewer recaptures, whereas those in Fortune Bay have resulted in intermediate numbers of recaptures. Overall, the numbers of returns appears to be tracking the changes in landings reasonably well, with the highest numbers of tag returns in 1999 coinciding with the 30,000 t TAC in that year.

Exploitation rates

Annual estimates of exploitation rate for each tagging experiment are summarized and grouped by area of release in Table 4. Since tagging has been conducted in some locations for several years, there are multiple estimates of exploitation for many areas, particularly Placentia Bay
Tagging coverage has been too limited in the western portion of the inshore (i.e. 3Psa) to draw firm conclusions about exploitation rates of cod tagged in that region. Among cod tagged in Fortune Bay, estimates of exploitation have been fairly consistent, ranging from 0.11 to 0.22 during 1998-2000; values for 2001 for all regions are preliminary as the fishery was still in progress. Among cod tagged in Placentia Bay, estimates of exploitation were $\leq$0.17 in 1997 and 1998, but during 1999 and 2000 were even higher with many estimates over 0.30. The mean exploitation rates in 1999 and 2000 for Placentia Bay were 0.24 and 0.27. Among cod tagged in 3Psd, estimates of exploitation have been much lower than those for cod tagged in Placentia Bay, ranging from 0.05 to 0.13 during 1998-2000. Cod tagged in Halibut Channel have consistently shown lowest levels of exploitation (0 to 0.06), in spite of substantial landings, particularly in 2000 (see Table 2).

Spatial and temporal distribution of recaptures

Annual summaries of the distribution of recaptures, grouped by year and unit area of release, are given in Table 5. Most cod tagged in Fortune Bay have been recaptured in Fortune Bay or eastward in neighbouring Placentia Bay, even 2-3 years later. Small proportions have also been recovered from more distant regions such as southern 3L, offshore 3Ps, and 3Pn4RS, but in general there are no strong indications of any progressive dispersal away from the tagging region. Similarly, cod tagged in Placentia Bay have mostly been recaptured within Placentia Bay; even 4-5 years after tagging typically over 80% of the recoveries have come from within Placentia Bay. In each year, small proportions of recaptures have come from southern 3L and more rarely northern 3L (i.e. 3La, 3Lb) or 3K, as well as westward into Fortune Bay and offshore 3Ps.

Cod tagged offshore in Halibut Channel have been recaptured mostly in the offshore of 3Ps or have migrated shoreward and been captured in Placentia Bay, around the Avalon Peninsula (3Lq, 3Lj, 3Lf), or rarely much further north in 3L (3La, 3Lb) or 3K. A few have also been recaptured in 3NO where the directed fishery for cod is still under moratorium.

Cod tagged offshore in 3Psd (Hermitage Channel and southern Burgeo Bank) have tended to migrate into 3Pn-4RS or disperse inshore along the south coast of Newfoundland in unit areas 3Psa, 3Psb, and 3Psc. The proportion of recaptures from 3Pn4RS varies annually and appears to

be higher from the 1998 and 2001 releases (range 46.4-72.5%) compared to the 1999 releases (range 10.9-24.4%).

Plots showing the distribution of recaptures for tagging experiments conducted in 2000 and 2001 are shown in Figs. 2-10. Plots for tagging experiments conducted at similar locations in 3Ps during 1998 and 1999 are shown in Brattey et al. (2000) Only recaptures where the exact location was reported are shown in these plots. Comparison of the results indicates general consistency in the pattern of recoveries over the 4 yr time span of these tagging experiments.

Cod tagged in Halibut Channel have typically been recaptured offshore close to the tagging site, inshore in Placentia Bay, or around coast of the Avalon Peninsula (Fig. 2). The absence of recaptures from offshore 3Ps in 2001 can probably be attributed to the low landings in this region up to September 2001 (see Table 2).

Cod tagged in Fortune Bay, either off Pass Island (Fig. 3) or near Pool's Cove (Fig. 4, 5) have mostly been recaptured within Fortune Bay, eastward into Placentia Bay, or more rarely westward in 3Psa, 4R-3Pn, or offshore 3Ps.

Several thousand cod have been tagged near the head of Placentia Bay in recent years and the distribution of recaptures from the tagging in 2000 and 2001 (Figs. 6-8) are generally consistent with those in 1997-1999. Many recaptures have been reported from the inner reaches of Placentia Bay, as well as along the eastern side, particularly close to the boundary with 3Lq. As in 1998 and 1999, there were some recaptures in 3L as far north as eastern Trinity Bay. A notable difference was the lack of recaptures in the eastern Avalon (particularly southern 3Lj) in 2000 and 2001 compared to 1998 and 1999 (see Fig. 16 in Brattey et al. 2000). There were substantial numbers of recaptures off St. Shotts in 3Lq (Figs. 6-8) indicating some concentration of fishing effort and local aggregation of cod in that area in 2001. There were small numbers of recaptures from offshore regions of 3Ps (i.e. 3Psh), but the majority of cod tagged in Placentia Bay have been recaptured within the 3Psc unit area.

Cod tagged in the Burgeo Bank-Hermitage Channel area in 2001 dispersed widely from the tagging site and were recaptured mostly in 3Pn-4RS and less commonly in the inshore of 3Ps (Fig. 9). Almost all the reported recaptures were taken close to shore. A similar wide dispersal was reported in for the tagging in this region in 1998 and 1999, but no cod for tagging were encountered in this region in April 2000 (Brattey et al. (2000). In contrast, cod tagged on the NW edge of St. Pierre Bank 1-2 days later and only 26 miles to the south (across the Hermitage Channel) mostly moved only short distances onto St. Pierre Bank, or more rarely inshore to the south coast (Fig. 10).

Discussion

Overall, the post-moratorium cod tagging studies in 3Ps give strong evidence of limited mixing, at least as adults, between cod occupying different portions of the 3Ps management area. There are indications of strong inshore residency among fish tagged in spring in Fortune Bay and Placentia Bay. Although these fish appear to disperse widely along the inshore during summer,

even extending well into 3L in some years, there appears to be limited offshore movement of these cod. The inshore sub-components are supplemented by seasonal migrants from offshore areas such as Halibut Channel, particularly in Placentia Bay, but many of the cod tagged offshore appear to remain offshore throughout the year. In the Burgeo area, the tagging results suggests that there may be mixing of 3Ps cod with those from 3Pn4RS even as late as mid-April, but the extent of mixing appears to vary annually and the precise stock affinity of these fish remains difficult to determine. Nonetheless, the tagging studies suggest that the cod found in the Burgeo Bank-Hermitage Channel area in April have not been heavily exploited (0.05 to 0.13), either in 3Ps or 3Pn-4RS (see Tables 4 and 5).

Fishery selectivity is not formally taken into account in the current analyses and exploitation rates on specific size (age) groups of cod may differ from those reported here. Gear types used in the 3Ps cod fishery differ across the stock area, with 5½ to 6½" mesh gill nets predominating in Placentia Bay (3Psc), line-trawl predominating in the western portion of the inshore (3Psa), and otter trawl in the offshore (3Psh)(see Brattey et al 2001). Cadigan and Brattey (2001) showed using the tagging data that the relative selectivity of gill nets in 3Ps in the post-moratorium period is dome-shaped with a peak selectivity at around 76 cm FL. Average sizes of tagged cod (see Table 1) are generally below the peak selectivity of the gill net fishery in the year of release, but these cod would grow and be optimally selected in subsequent years. Differences in length frequency among tagged cod in each experiment may therefore account for some of the variability in exploitation rates.

The results from post-moratorium cod tagging studies have provided important new information about how different components of the stock in 3Ps are being exploited. With limited mixing between inshore and offshore, the inshore stock components are much more prone to excessive exploitation because of the heavy inshore fishing effort, particularly in Placentia Bay. Furthermore, the decline in the sentinel gillnet catch rates and high exploitation rates in this region estimated from tag returns suggests that local depletion of inshore cod has occurred, particularly during 1999 and 2000. Exploitation rates for cod tagged in Placentia Bay appear to be too high, and the results of the tagging analyses indicate that measures should be introduced to lower the exploitation rate in this portion of the stock area. For the levels of exploitation observed in 1999 and 2000 to be sustainable, there would have to be strong recruitment coming into this portion of the stock, yet the available evidence suggests that recruitment in 3Ps during the mid 1990's has been relatively weak (see Brattey et al 2001).

The estimates of exploitation for the offshore are substantially lower than those for the inshore, in spite of substantial offshore landings, and concerns were expressed at the assessment meeting that the estimates for the offshore may be too low. Possible reasons include limited tagging coverage (both spatial and temporal) and restricted distribution of fishing activity in the offshore, and possibly lower survival of fish caught for tagging offshore in deep-water. There have been substantial landings in some portions of the offshore where little or no tagging has been conducted (see Fig. 1 and Table 2) and more extensive tagging coverage, particularly on St. Pierre Bank, would clearly be beneficial to address this concern.

The limited mixing between inshore and offshore cod further suggests that sentinel catch rates are mostly providing information about resident inshore fish rather than the stock as a whole.

Sentinel catch rates may therefore be influenced by annual variability in the extent to which offshore cod migrate to the inshore. Thus, the influence of sentinel catch rates must be carefully considered when they are included as an index in sequential population analysis of the whole stock.

Acknowledgements

We thank the sentinel and commercial fishers and staff of the Fisheries Evaluation, Gadoids, and Commercial Sampling Sections of DFO Newfoundland Region for conducting the tagging experiments; C. George, D. Porter, P. Upward, and S. North collated the release and recapture information. We also gratefully acknowledge the assistance of Fisheries Officers and Observers in implementing the tagging program, and thank the numerous fishers and plant workers for returning tags and recapture information. This study was funded by the DFO under the Strategic Science Fund program.

References

Brattey, J. 1999. Stock structure and seasonal migration patterns of Atlantic cod (*Gadus morhua*) based on inshore tagging experiments in Divs. 3KL during 1995-97. DFO Canadian Stock Assessment Secretariat Research Document 99/103.

Brattey, J. 2000. Stock structure and seasonal movements of Atlantic cod (*Gadus morhua*) in NAFO Divs. 3KL inferred from recent tagging experiments. Canadian Stock Assessment Secretariat Res. Doc. 2000/084.

Brattey, J., and N. Cadigan. 2001. Estimation of short-term tagging mortality of adult Atlantic cod (*Gadus morhua*). ICES CM 2001 O:03.

Brattey, J., N. G. Cadigan, G. R. Lilly, E. F. Murphy, P. A. Shelton, and D. E. Stansbury. 2000. An assessment of the cod stock in NAFO Subdivision 3Ps in October 2000. DFO Canadian Stock Assessment Secretariat Research Document 2000/134.

Brattey, J., N. G. Cadigan, G. R. Lilly, E. F. Murphy, P. A. Shelton, D. E. Stansbury, and J.-C. Mahé. 2001. An assessment of the cod stock in NAFO Subdivision 3Ps in October 2000. DFO Canadian Stock Assessment Secretariat Research Document 2001/099.

Brattey, J., G. Lawson, and G. Rose. 1999. Seasonal migration patterns of Atlantic cod (*Gadus morhua*) in Subdivision 3Ps based on tagging experiments during 1997-1998. Canadian Stock Assessment Secretariat Res. Doc. 99/37.

Cadigan, N. G. and J. Brattey. 1999a. Tag loss and reporting rates for 1997 and 1998 cod tagging experiments in 3Psc and 3KL. Canadian Stock Assessment Secretariat Research. Document 99/65.

Cadigan, N. G. and J. Brattey. 1999b. Estimation of exploitation and migration rates of Atlantic cod (*Gadus morhua*) in Subdiv. 3Ps and Divs. 3KL during 1997 and 1998 based on tagging experiments. Canadian Stock Assessment Secretariat Research. Document 99/38.

Cadigan, N., and J. Brattey. 2000a. Lower bounds on the exploitation of Atlantic cod (*Gadus morhua*) in NAFO Divs. 3KL and Subdiv. 3Ps in 1997-1999 from tagging experiments. DFO Canadian Stock Assessment Secretariat Research Document 2000/073.

Cadigan, N. G. and J. Brattey. 2000b. Estimation of cod growth in Subdiv. 3Ps and Divs. 3KL in 1997-1999 from tagging experiments. Canadian Stock Assessment Secretariat Research. Document 2000/074.

Cadigan, N., and J. Brattey. 2001. Estimation of exploitation rates and migration rates for cod (*Gadus morhua*) in NAFO Divisions 3KL and Subdiv. 3Ps during 1997-2000 from tagging experiments. ICES CM 2001/O:4.

Lawson, G. L., G. A. Rose, and J. Brattey. 1998. Movement patterns of inshore cod in Subdivision 3Ps (southern Newfoundland) based on mark-recapture studies during 1996/97. DFO Canadian Stock Assessment Secretariat Research Document 98/24.

Lilly, G. R., P. A. Shelton, J. Brattey, N. Cadigan, E. F. Murphy, D. E. Stansbury. 2001. An assessment of the cod stock in NAFO Divisions 2J+3KL. Canadian Stock Assessment Secretariat Res. Doc. 2001/044.

Myers, R. A., N. J. Barrowman, J. M. Hoenig, and Z. Qu. 1996. The collapse of cod in eastern Canada: the evidence from tagging data. ICES J. Mar. Sci. 53: 629-640.

Myers, R. A., N. J. Barrowman, and J. A. Hutchings. 1997. Inshore exploitation of Newfoundland Atlantic cod (*Gadus morhua*) since 1948 as estimated from mark-recapture data. Can. J. Fish. Aquat. Sci. 54: 224-235.

Pope, J. and J. Brattey 2001. A charmingly simple tagging model. Canadian Stock Assessment Secretariat Res. Doc. 2001/082.

Taggart, C. T., P. Penney, N. Barrowman, and C. George. 1995. The 1954-1993 Newfoundland cod-tagging database: statistical summaries and spatial-temporal distributions. Canadian Technical Report of Fisheries and Aquatic Sciences 2042: 441p.

Table 1. Summary of details for cod tagging experiments conducted in NAFO Subdiv. during 1997-2001 (PB=Placentia Bay, FB=Fortune Bay, HB=Hermitage Bay).

DFO Stat. area	Year & expt no.	Area of release	Dates	Gear	Depth (m)	Number tagged	Mean length (cm)
3Psc	1997-001	Bar Haven, NW PB	9-12 Apr.	handline	48-60	996	62.1
3Psc	1997-002	Clattice Hbr., NW PB	10 Apr.	handline	58-60	966	52.3
3Psc	1997-004	Bar Haven, NW PB	17-18 May	handline	50	817	65.0
3Psc	1997-005	St. Bride's, SE PB	25-28 May	handline	40	709	66.4
3Psc	1997-006	Oderin Bank, W PB	24-26 Jun.	handline	40	963	58.9
3Psc	1997-008	Lord's Cove, SW PB	25 Jun.-18 Jul.	trap/handline	18-40	793	53.5
3Psc	1997-015	Iona Islands, E PB	6-8 Nov.	handline	30-50	778	61.3
3Psh	1998-001	Halibut Channel	2-5 Apr.	otter trawl	181-307	1842	63.9
3Psd	1998-002	Hermitage Channel	5-7 Apr.	otter trawl	231-344	1352	53.9
3Psc	1998-003	Bar Haven, NW PB	22-25 April	handline	21-50	2073	61.0
3Psc	1998-004	Paradise Sound, W PB	27-29 April	otter trawl	151-206	1212	60.8
3Psc	1998-005	Wareham Rock, NW PB	May 1-3	handline	41-53	1037	61.9
3Psb	1998-006	Pool's Cove, FB	May 20-29	handline	67	938	57.5
3Psc	1998-007	Bar Haven, NW PB	19-24 Oct.	handline/otter trl.	41-60	511	60.3
3Psc	1998-008	Eastern Channel, PB	17-22 Oct.	handline	52-80	883	58.8
3Psb	1999-003	South of Pass Island, FB	8 Apr.	otter trawl	211-217	1293	57.0
3Psc	1999-004	head of Placentia Bay	29 Apr.-7 May	handline	20-70	2422	63.2
3Psd	1999-002	Hermitage Channel	4-7 Apr.	otter trawl	192-322	464	59.8
3Psh	1999-001	Halibut Channel	1-3 Apr.	otter trawl	149-239	1808	68.0
3Psc	1999-039	head of Placentia Bay	8-17 Nov	h'line/otter tr'l	50	2152	63.0
3Psb	1999-043	Hermitage Bay	30 Nov-1 Dec	handline	50	57	52.9
3Psh	2000-001	Halibut Channel	1-7 Apr	otter trawl	203-259	1044	85.8
3Psd	2000-003	Burgeo Bank	4-Apr	otter trawl	212-318	5	77.0
3Psb	2000-004	Pass Island	5-7 Apr	otter trawl	136-220	1665	53.1
3Psb	2000-006	Pool's Cove, FB	17-19 Apr	line-trawl	60-112	752	55.0
3Psc	2000-007	inner Placentia Bay	26 Apr - 6 May	handline	16-50	2494	60.5
3Psc	2000-008	inner Placentia Bay	27 Apr - 4 May	otter trawl	30-107	528	59.2
3Psc	2000-033	Bar Haven, PB	5-12 Nov.	handline	33-55	1165	59.0
3Psc	2000-034	Saturday Ledge, PB	10-12 Nov.	otter trawl	35-55	792	58.7
3Psc	2000-035	Eastern Channel, PB	13-15 Nov.	handline	35-63	1212	58.7
3Psb	2001-001	Pool's Cove, FB	9-11 Jan.	handline	55-92	200	57.5
3Psb	2001-002	Pool's Cove, FB	9-11 Jan.	linetrawl	73-92	388	56.1
3Psh	2001-003	Halibut Channel	12-14 Apr.	otter trawl	170-248	1144	80.8
3Psd/a	2001-006	Burgeo Bank	15-17 Apr.	otter trawl	179	999	53.8
3Psd	2001-007	NW St. Pierre Bank	16-17 Apr.	otter trawl	186-193	666	89.0
3Psb	2001-008	Pass Island, FB	18 Apr.	otter trawl	178-224	477	54.8
3Psb	2001-009	Fortune Bay	25-26 Apr.	handline	50-185	60	52.8
3Psc	2001-010	inner Placentia Bay	28 Apr.-6 May	otter trawl	35-230	1704	57.1
3Psc	2001-011	inner Placentia Bay	28 Apr.-7 May	handline	30-60	2273	58.7

Table 2. Reported monthly landings (t) of cod from unit areas in NAFO Subdiv. 3Ps during 2000 and 2001 (to 1 Oct 2001).

2000	Inshore			Offshore					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**3Ps_unk**
Jan	3.1	4.0	962.2	11.4	0.0	10.0	4.9	1243.8	0.0
Feb	3.9	1.2	1310.1	0.0	0.0	0.0	7.0	2348.5	0.0
Mar	173.9	626.6	164.2	1.6	0.0	0.0	11.4	1397.3	0.0
Apr	3.4	0.0	0.0	12.0	0.0	7.4	0.7	196.5	0.0
May	29.4	23.7	4.1	5.7	0.0	0.3	0.5	20.1	0.0
Jun	378.6	741.5	1309.3	28.6	52.4	624.0	12.5	109.3	0.0
Jul	122.0	152.9	1159.8	14.3	206.0	179.6	3.3	55.1	0.0
Aug	28.1	37.2	219.3	7.3	227.1	74.8	11.0	35.2	0.0
Sep	386.2	298.0	262.3	115.2	280.2	648.7	44.9	192.3	13.1
Oct	10.5	4.6	485.3	0.0	127.0	779.1	14.2	420.7	0.0
Nov	537.6	319.2	2412.6	51.5	104.1	837.3	34.6	876.1	0.0
Dec	41.6	54.1	484.4	1.3	6.0	22.0	10.9	846.7	0.0
Totals	1718.3	2263.0	8773.6	248.9	1002.8	3183.1	155.8	7741.6	13.1

2001	Inshore			Offshore					
Month	**3Psa**	**3Psb**	**3Psc**	**3Psd**	**3Pse**	**3Psf**	**3Psg**	**3Psh**	**3Ps_unk**
Jan	0.4	22.0	880.2	1.0	9.4	143.7	3.4	549.5	0.0
Feb	0.4	4.3	26.1	6.2	119.7	270.0	7.1	662.4	0.0
Mar	2.7	15.0	31.0	58.6	57.7	222.6	1.3	364.6	1.9
Apr	0.3	0.0	0.2	6.8	1.2	1.2	0.0	16.2	0.0
May	12.5	5.4	1.5	31.5	32.8	0.0	0.0	42.2	0.0
Jun	131.5	424.1	717.3	2.8	13.0	0.7	0.1	4.2	0.0
Jul	183.4	499.8	1195.8	15.4	7.9	4.6	0.0	11.8	17.2
Aug	142.0	447.9	537.5	49.7	19.9	10.3	10.1	27.8	38.8
Sep	168.5	522.4	495.1	2.2	2.0	24.9	14.3	7.0	1.5
Oct	3.8	76.7	49.9	.	.	.	.	.	.
Nov	.	.	.	.	.	.	.	.	.
Dec	.	.	.	.	.	.	.	.	.
Totals	645.4	2017.7	3934.5	174.1	263.5	677.9	36.3	1685.7	59.3

Table 3. Annual summary of reported recaptures (all tag types combined) for cod tagged and released in NAFO Subdiv. 3Ps during 1997-2001(PB=Placentia Bay, FB=Fortune Bay, HB=Hermitage Bay).

Year & expt no.	DFO Stat. area	Area of release	Dates	Number tagged	Reported recaptures 1997	1998	1999	2000	2001*
1997-001	3Psc	Bar Haven, NW PB	9-12 Apr.	996	78	69	73	38	6
1997-002	3Psc	Clattice Hbr., NW PB	10 Apr.	966	91	42	53	31	3
1997-004	3Psc	Bar Haven, NW PB	17-18 May	817	103	43	83	50	4
1997-005	3Psc	St. Bride's, SE PB	25-28 May	709	27	46	86	41	5
1997-006	3Psc	Oderin Bank, W PB	24-26 Jun.	963	16	57	35	21	6
1997-008	3Psc	Lord's Cove, SW PB	25 Jun.-18 Jul.	793	27	69	49	25	3
1997-015	3Psc	Iona Islands, E PB	6-8 Nov.	778	0	39	88	33	7
1998-001	3Psh	Halibut Channel	2-5 Apr.	1842	.	24	23	15	3
1998-002	3Psd	Hermitage Channel	5-7 Apr.	1352	.	39	49	22	3
1998-003	3Psc	Bar Haven, NW PB	22-25 April	2073	.	124	308	142	18
1998-004	3Psc	Paradise Sound, W PB	27-29 April	1212	.	152	192	104	9
1998-005	3Psc	Wareham Rock, NW PB	May 1-3	1037	.	82	208	96	10
1998-006	3Psb	Pool's Cove, FB	May 20-29	938	.	87	91	43	8
1998-007	3Psc	Bar Haven, NW PB	19-24 Oct.	511	.	6	79	37	14
1998-008	3Psc	Eastern Channel, PB	17-22 Oct.	883	.	29	102	85	24
1999-001	3Psh	Halibut Channel	1-3 Apr	1808	.	.	39	45	14
1999-002	3Psd	Hermitage Channel	4-7 Apr	464	.	.	29	12	1
1999-003	3Psb	Pass Island, FB	8-Apr	1293	.	.	76	59	11
1999-004	3Psc	inner Placentia Bay	29 Apr.-7 May	2422	.	.	404	290	47
1999-039	3Psc	inner Placentia Bay	8-17 Nov	2152	.	.	69	368	44
1999-043	3Psb	Hermitage Bay	30 Nov-1 Dec	57	.	.	1	6	1
2000-001	3Psh	Halibut Channel	1-7 Apr	1044	.	.	.	2	10
2000-003	3Psd	Burgeo Bank	4-Apr	5	.	.	.	0	0
2000-004	3Psb	Pass Island	5-7 Apr	1665	.	.	.	92	17
2000-006	3Psb	Pool's Cove, FB	17-19 Apr	752	.	.	.	59	21
2000-007	3Psc	inner Placentia Bay	26 Apr - 6 May	2494	.	.	.	309	105
2000-008	3Psc	inner Placentia Bay	27 Apr - 4 May	528	.	.	.	64	22
2000-033	3Psc	Bar Haven, PB	5-12 Nov	1165	.	.	.	40	62
2000-034	3Psc	Saturday Ledge, PB	10-12 Nov	792	.	.	.	39	37
2000-035	3Psc	Eastern Channel, PB	13-15 Nov	1212	.	.	.	47	63
2001-001	3Psb	Pool's Cove, FB	9-11 Jan	200	.	.	.	.	11
2001-002	3Psb	Pool's Cove, FB	9-11 Jan	388	.	.	.	.	22
2001-003	3Psh	Halibut Channel	12-14 Apr	1144	.	.	.	.	5
2001-006	3Psd/a	Burgeo Bank	15-17 Apr	999	.	.	.	.	23
2001-007	3Psd	NW St. Pierre Bank	16-17 Apr	666	.	.	.	.	16
2001-008	3Psb	Pass Island, FB	18-Apr	477	.	.	.	.	1
2001-009	3Psb	Fortune Bay	25-26 Apr	60	.	.	.	.	1
2001-010	3Psc	inner Placentia Bay	28 Apr.-6 May	1704	.	.	.	.	55
2001-011	3Psc	inner Placentia Bay	28 Apr.-7 May	2273	.	.	.	.	54

* received up to 30 September 2001

M121

IMPORTANT NOTE CONCERNING THE FOLLOWING PAGES

THE PAGES WHICH FOLLOW HAVE BEEN FILMED TWICE IN ORDER TO OBTAIN THE BEST REPRODUCTIVE QUALITY

USERS SHOULD CONSULT ALL THE PAGES REPRODUCED ON THE FICHE IN ORDER TO OBTAIN A COMPLETE READING OF THE TEXT.

REMARQUE IMPORTANTE CONCERNANT LES PAGES QUI SUIVENT

LES PAGES SUIVANTES ONT ÉTÉ REPRODUITES EN DOUBLE AFIN D'AMÉLIORER LA QUALITÉ DE REPRODUCTION

LES UTILISATEURS DOIVENT CONSULTER TOUTES LES PAGES REPRODUITES SUR LA FICHE AFIN D'OBTENIR LA LECTURE DU TEXTE INTÉGRAL

Micromedia
ProQuest

20 Victoria Street
Toronto, Ontario M5C 2N8
Tel.: (416) 362-5211
Toll Free: 1-800-387-2689
Fax: (416) 362-6161
Email: info@micromedia.on.ca

Table 4. Annual estimates of exploitation (harvest rates) by experiment for cod tagged in NAFO Subdiv. 3Ps during 1997-2001. Recaptures were adjusted to account for reporting rate and releases were adjusted to account for tagging mortality, tag loss, and assumed natural mortality. Shaded cells represent estimates for experiments conducted during the fishing season and account for only a portion of exploitation in the year of release. See text for further details.

					Reported landings (t)				
					9,045	19,694	28,111	25,100	9,494
DFO Stat.	Year &			Number	Exploitation rates				
area	expt no.	Area of release	Dates	tagged	1997	1998	1999	2000	2001*
3Psa	1999-043	Hermitage Bay	30 Nov-1 Dec	57	.	.	0.04	0.20	0.07
3Psb	1998-006	Pool's Cove, FB	May 20-29	938	.	0.14	0.22	0.16	0.05
3Psb	1999-003	Pass Island, FB	8-Apr	1293	.	.	0.11	0.12	0.03
3Psb	2000-004	Pass Island	5-7 Apr	1665	.	.	.	0.11	0.03
3Psb	2000-006	Pool's Cove, FB	17-19 Apr	752	.	.	.	0.16	0.08
3Psb	2001-001	Pool's Cove, FB	9-11 Jan	200	.	.	.	.	0.11
3Psb	2001-002	Pool's Cove, FB	9-11 Jan	388	.	.	.	.	0.13
3Psb	2001-008	Pass Island, FB	18-Apr	477	.	.	.	.	0.01
3Psb	2001-009	Fortune Bay	25-26 Apr	60	.	.	.	.	0.04
3Psc	1997-001	Bar Haven, NW PB	9-12 Apr.	996	0.11	0.14	0.22	0.16	0.04
3Psc	1997-002	Clattice Hbr., NW PB	10 Apr.	966	0.13	0.09	0.16	0.13	0.02
3Psc	1997-004	Bar Haven, NW PB	17-18 May	817	0.17	0.11	0.30	0.29	0.03
3Psc	1997-005	St. Bride's, SE PB	25-28 May	709		0.13	0.33	0.26	0.05
3Psc	1997-006	Oderin Bank, W PB	24-26 Jun.	963		0.12	0.10	0.08	0.03
3Psc	1997-008	Lord's Cove, SW PB	25 Jun.-18 Jul.	793		0.15	0.16	0.11	0.02
3Psc	1997-015	Iona Islands, E PB	6-8 Nov.	778		0.08	0.25	0.14	0.04
3Psc	1998-003	Bar Haven, NW PB	22-25 April	2073	.	0.09	0.31	0.23	0.04
3Psc	1998-004	Paradise Sound, W PB	27-29 April	1212	.	0.19	0.36	0.35	0.06
3Psc	1998-005	Wareham Rock, NW PB	May 1-3	1037	.	0.12	0.43	0.39	0.08
3Psc	1998-008	Bar Haven, NW PB	19-24 Oct.	511	.		0.25	0.17	0.09
3Psc	1998-009	Eastern Channel, PB	17-22 Oct.	883	.		0.19	0.23	0.10
3Psc	1999-004	inner Placentia Bay	29 Apr.-7 May	2422	.	.	0.30	0.33	0.10
3Psc	1999-039	inner Placentia Bay	8-17 Nov	2152	.	.		0.29	0.06
3Psc	2000-007	inner Placentia Bay	26 Apr - 6 May	2494	.	.	.	0.22	0.10
3Psc	2000-008	inner Placentia Bay	27 Apr - 4 May	528	.	.	.	0.21	0.10
3Psc	2000-033	Bar Haven, PB	5-12 Nov	1165	.	.	.	0.05	0.09
3Psc	2000-034	Saturday Ledge, PB	10-12 Nov	792	.	.	.		0.09
3Psc	2000-035	Eastern Channel, PB	13-15 Nov	1212	.	.	.		0.09
3Psc	2001-010	inner Placentia Bay	28 Apr.-6 May	1704	.	.	.	.	0.05
3Psc	2001-011	inner Placentia Bay	28 Apr.-7 May	2273	.	.	.	.	0.04
3Psd	1998-002	Hermitage Channel	5-7 Apr.	1352	.	0.05	0.08	0.05	0.01
3Psd	1999-002	Hermitage Channel	4-7 Apr	464	.	.	0.13	0.08	0.01
3Psd	2001-007	NW St. Pierre Bank	16-17 Apr	666	.	.	.	.	0.05
3Psd/a	2001-006	Burgeo Bank	15-17 Apr	999	.	.	.	.	0.08
3Psh	1998-001	Halibut Channel	2-5 Apr.	1842	.	0.02	0.03	0.02	0.01
3Psh	1999-001	Halibut Channel	1-3 Apr	1808	.	.	0.04	0.06	0.02
3Psh	2000-001	Halibut Channel	1-7 Apr	1044	.	.	.	0.00	0.02
3Psh	2001-003	Halibut Channel	12-14 Apr	1144	.	.	.	.	0.01

* based on tags received up to 30 September 2001

Table 4. Annual estimates of exploitation (harvest rates) by experiment for cod tagged in NAFO Subdiv. 3Ps during 1997-2001. Recaptures were adjusted to account for reporting rate and releases were adjusted to account for tagging mortality, tag loss, and assumed natural mortality. Shaded cells represent estimates for experiments conducted during the fishing season and account for only a portion of exploitation in the year of release. See text for further details.

					Reported landings (t)				
					9,045	19,694	28,111	25,100	9,494
DFO Stat.	Year &			Number	Exploitation rates				
area	expt no.	Area of release	Dates	tagged	1997	1998	1999	2000	2001*
3Psa	1999-043	Hermitage Bay	30 Nov-1 Dec	57	.	.	0.04	0.20	0.07
3Psb	1998-006	Pool's Cove, FB	May 20-29	938	.	0.14	0.22	0.16	0.05
3Psb	1999-003	Pass Island, FB	8-Apr	1293	.	.	0.11	0.12	0.03
3Psb	2000-004	Pass Island	5-7 Apr	1665	.	.	.	0.11	0.03
3Psb	2000-006	Pool's Cove, FB	17-19 Apr	752	.	.	.	0.16	0.08
3Psb	2001-001	Pool's Cove, FB	9-11 Jan	200	.	.	.	.	0.11
3Psb	2001-002	Pool's Cove, FB	9-11 Jan	388	.	.	.	.	0.13
3Psb	2001-008	Pass Island, FB	18-Apr	477	.	.	.	.	0.01
3Psb	2001-009	Fortune Bay	25-26 Apr	60	.	.	.	.	0.04
3Psc	1997-001	Bar Haven, NW PB	9-12 Apr.	996	0.11	0.14	0.22	0.16	0.04
3Psc	1997-002	Clattice Hbr., NW PB	10 Apr.	966	0.13	0.09	0.16	0.13	0.02
3Psc	1997-004	Bar Haven, NW PB	17-18 May	817	0.17	0.11	0.30	0.29	0.03
3Psc	1997-005	St. Bride's, SE PB	25-28 May	709	[redacted]	0.13	0.33	0.26	0.05
3Psc	1997-006	Oderin Bank, W PB	24-26 Jun.	963	[redacted]	0.12	0.10	0.08	0.03
3Psc	1997-008	Lord's Cove, SW PB	25 Jun.-18 Jul.	793	[redacted]	0.15	0.16	0.11	0.02
3Psc	1997-015	Iona Islands, E PB	6-8 Nov.	778	[redacted]	0.08	0.25	0.14	0.04
3Psc	1998-003	Bar Haven, NW PB	22-25 April	2073	.	0.09	0.31	0.23	0.04
3Psc	1998-004	Paradise Sound, W PB	27-29 April	1212	.	0.19	0.36	0.35	0.06
3Psc	1998-005	Wareham Rock, NW PB	May 1-3	1037	.	0.12	0.43	0.39	0.08
3Psc	1998-008	Bar Haven, NW PB	19-24 Oct.	511	.	[redacted]	0.25	0.17	0.09
3Psc	1998-009	Eastern Channel, PB	17-22 Oct.	883	.	[redacted]	0.19	0.23	0.10
3Psc	1999-004	inner Placentia Bay	29 Apr.-7 May	2422	.	.	0.30	0.33	0.10
3Psc	1999-039	inner Placentia Bay	8-17 Nov	2152	.	.	[redacted]	0.29	0.06
3Psc	2000-007	inner Placentia Bay	26 Apr - 6 May	2494	.	.	.	0.22	0.10
3Psc	2000-008	inner Placentia Bay	27 Apr - 4 May	528	.	.	.	0.21	0.10
3Psc	2000-033	Bar Haven, PB	5-12 Nov	1165	.	.	.	0.05	0.09
3Psc	2000-034	Saturday Ledge, PB	10-12 Nov	792	.	.	.	[redacted]	0.09
3Psc	2000-035	Eastern Channel, PB	13-15 Nov	1212	.	.	.	[redacted]	0.09
3Psc	2001-010	inner Placentia Bay	28 Apr.-6 May	1704	.	.	.	.	0.05
3Psc	2001-011	inner Placentia Bay	28 Apr.-7 May	2273	.	.	.	.	0.04
3Psd	1998-002	Hermitage Channel	5-7 Apr.	1352	.	0.05	0.08	0.05	0.01
3Psd	1999-002	Hermitage Channel	4-7 Apr	464	.	.	0.13	0.08	0.01
3Psd	2001-007	NW St. Pierre Bank	16-17 Apr	666	.	.	.	.	0.05
3Psd/a	2001-006	Burgeo Bank	15-17 Apr	999	.	.	.	.	0.08
3Psh	1998-001	Halibut Channel	2-5 Apr.	1842	.	0.02	0.03	0.02	0.01
3Psh	1999-001	Halibut Channel	1-3 Apr	1808	.	.	0.04	0.06	0.02
3Psh	2000-001	Halibut Channel	1-7 Apr	1044	.	.	.	0.00	0.02
3Psh	2001-003	Halibut Channel	12-14 Apr	1144	.	.	.	.	0.01

* based on tags received up to 30 September 2001

Table 5. Annual distribution of recaptures of cod tagged and released in various regions of NAFO Subdiv. 3Ps during 1997-2001. Recaptures were adjusted by region-specific reporting rates obtained from a high-reward tagging study. Shaded cells give the percentage recaptured in the area of release. Values for 2001 are based on tags received up to September 2001.

Release area	Year	Number tagged	Recaptures Year	Recaptures Adjusted total	% of total reported recaptured by area 3K	3LA (Bonavista)	3LB (Trinity)	3LF (Conception)	3LJ (E. Avalon)	3LQ (S. Avalon)	3NO (G. Banks)	3PSA (Burgeo N)	3PSB (Fortune)	3PSC (Placentia)	3PSD (Burgeo S)	3PS_off (offshore)	3Pn-4RS
3Psa	1999	57	1999	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[redacted]	100.0	0.0	0.0	0.0	0.0
			2000	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[redacted]	83.3	0.0	0.0	0.0	0.0
			2001	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[redacted]	100.0	0.0	0.0	0.0	0.0
3Psb	1998	939	1998	136	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	[redacted]	16.2	0.0	0.0	7.0
			1999	139	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	[redacted]	17.8	0.0	0.0	6.9
			2000	64	0.0	0.0	0.0	0.0	2.3	0.0	0.0	5.0	[redacted]	18.3	0.0	2.4	0.0
			2001	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.6	[redacted]	10.5	0.0	0.0	0.0
	1999	1293	1999	106	0.0	0.0	1.3	0.0	1.4	1.4	0.0	4.5	[redacted]	58.7	0.0	1.4	0.0
			2000	87	0.0	0.0	0.0	3.4	1.7	1.7	0.0	1.8	[redacted]	37.5	0.0	3.5	2.8
			2001	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5	[redacted]	68.6	0.0	0.0	0.0
	2000	2417	2000	217	0.0	0.0	0.0	0.0	0.7	0.0	0.0	2.2	[redacted]	33.5	0.0	0.7	2.2
			2001	58	0.0	0.0	0.0	0.0	0.0	2.5	0.0	8.3	[redacted]	27.1	2.8	0.0	4.1
	2001	1125	2001	52	0.0	0.0	2.7	0.0	2.8	0.0	0.0	3.0	[redacted]	27.4	0.0	0.0	0.0
3Psc	1997	6022	1997	448	0.0	0.0	0.3	0.3	0.3	0.7	0.0	0.0	4.0	[redacted]	0.0	0.3	0.0
			1998	493	0.0	0.0	0.9	1.5	4.5	1.8	0.6	0.3	13.5	[redacted]	0.7	1.6	0.5
			1999	622	0.4	0.2	1.4	3.5	1.7	1.9	0.0	0.3	8.8	[redacted]	0.0	1.2	0.0
			2000	319	0.4	0.9	0.4	0.0	0.9	0.9	0.0	1.0	7.6	[redacted]	0.0	5.3	0.8
			2001	46	0.0	0.0	3.1	0.0	0.0	3.2	0.0	0.0	0.0	[redacted]	0.0	3.3	5.2
	1998	5808	1998	516	0.0	0.0	0.8	2.8	4.6	1.4	0.0	0.3	1.6	[redacted]	0.0	0.0	0.0
			1999	1189	0.3	0.2	2.4	2.6	2.5	1.6	0.0	0.3	4.7	[redacted]	0.0	0.9	0.0
			2000	635	0.6	0.2	0.7	0.5	0.5	2.3	0.0	0.3	5.8	[redacted]	0.0	1.7	0.8
			2001	101	2.5	0.0	1.4	0.0	2.9	2.9	0.0	0.0	6.4	[redacted]	0.0	1.5	0.0
	1999	4828	1999	677	0.0	0.0	0.8	0.4	0.9	0.7	0.0	0.0	1.2	[redacted]	0.0	0.0	0.0
			2000	909	0.0	0.0	0.3	0.3	0.5	1.1	0.0	0.0	3.4	[redacted]	0.0	0.3	0.0
			2001	126	0.0	0.0	0.0	2.3	2.3	3.5	0.0	0.0	2.5	[redacted]	0.0	4.9	0.0
	2000	6337	2000	672	0.0	0.0	0.0	0.0	0.4	1.3	0.0	0.0	1.9	[redacted]	0.2	0.0	0.0
			2001	388	0.0	0.0	1.1	1.1	2.6	6.8	0.0	0.0	1.2	[redacted]	0.0	2.0	0.0
	2001	6337	2001	145	0.9	0.0	0.0	4.1	0.0	17.2	0.0	0.0	3.3	[redacted]	0.0	0.0	0.0

Cont'd:-

Table 5. Cont'd.

Release area	Year	Number tagged	Recaptures Year	Recaptures Adjusted total	% of total reported recaptured by area 3K	3LA (Bonavista)	3LB (Trinity)	3LF (Conception)	3LJ (E. Avalon)	3LQ (S. Avalon)	3NO (G. Banks)	3PSA (Burgeo N)	3PSB (Fortune)	3PSC (Placentia)	3PSD (Burgeo S)	3PS_off (offshore)	3Pn-4RS
3Psd	1998	1352	1998	71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	9.0	20.2	22.5	2.1	57.4
				88	1.4	1.6	0.0	0.0	0.0	0.0	0.0	10.8	5.4	11.8	0.0	1.7	67.3
				43	3.0	0.0	0.0	0.0	0.0	0.0	0.0	11.2	3.7	6.1	0.0	3.6	72.5
				5	0.0	0.0	0.0	28.3	0.0	0.0	0.0	0.0	0.0	25.3	0.0	0.0	46.4
	1999	464	1999	44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.5	10.9	20.8	3.9	10.4	10.9
				19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	26.7	0.0	0.0	24.4
				1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
	2001	1665	2001	62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	2.6	4.2	18.1	19.7	50.3
3Psh	1998	1842	1998	34	0.0	0.0	0.0	4.3	0.0	0.0	4.5	0.0	0.0	19.3	0.0	71.9	0.0
			1999	33	0.0	0.0	0.0	4.5	4.5	0.0	0.0	0.0	0.0	27.9	0.0	65.1	7.3
			2000	21	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	7.7	18.9	0.0	66.4	0.0
			2001	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.2	0.0	36.8	0.0
	1999	1808	1999	49	2.6	0.0	2.9	2.9	8.8	2.9	6.1	0.0	0.0	36.9	0.0	34.9	0.0
			2000	53	0.0	0.0	0.0	5.5	0.0	2.8	2.9	0.0	0.0	22.2	6.0	60.5	0.0
			2001	18	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	42.5	0.0	49.6	0.0
	2000	1044	2000	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.2	0.0	48.8	0.0
			2001	12	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	22.3	0.0	65.3	0.0
	2001	1144	2001	7	0.0	0.0	19.6	0.0	20.2	0.0	0.0	0.0	0.0	18.1	0.0	42.2	0.0

Table 5. Annual distribution of recaptures of cod tagged and released in various regions of NAFO Subdiv. 3Ps during 1997-2001. Recaptures were adjusted by region-specific reporting rates obtained from a high-reward tagging study. Shaded cells give the percentage recaptured in the area of release. Values for 2001 are based on tags received up to September 2001.

Release area	Year	Number tagged	Recaptures Year	Recaptures Adjusted total	% of total reported recaptured by area 3K	3LA (Bonavista)	3LB (Trinity)	3LF (Conception)	3LJ (E. Avalon)	3LQ (S. Avalon)	3NO (G. Banks)	3PSA (Burgeo N)	3PSB (Fortune)	3PSC (Placentia)	3PSD (Burgeo S)	3PS_off (offshore)	3Pn-4RS
3Psa	1999	57	1999	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		100.0	0.0	0.0	0.0	0.0
			2000	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0		83.3	0.0	0.0	0.0	0.0
			2001	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0		100.0	0.0	0.0	0.0	0.0
3Psb	1998	939	1998	136	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0		16.2	0.0	0.0	7.0
			1999	139	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0		17.8	0.0	0.0	6.9
			2000	64	0.0	0.0	0.0	0.0	2.3	0.0	0.0	5.0		18.3	0.0	2.4	0.0
			2001	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.6		10.5	0.0	0.0	0.0
	1999	1293	1999	106	0.0	0.0	1.3	0.0	1.4	1.4	0.0	4.5		58.7	0.0	1.4	0.0
			2000	87	0.0	0.0	0.0	3.4	1.7	1.7	0.0	1.8		37.5	0.0	3.5	2.8
			2001	15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.5		68.6	0.0	0.0	0.0
	2000	2417	2000	217	0.0	0.0	0.0	0.0	0.7	0.0	0.0	2.2		33.5	0.0	0.7	2.2
			2001	58	0.0	0.0	0.0	0.0	0.0	2.5	0.0	8.3		27.1	2.8	0.0	4.1
	2001	1125	2001	52	0.0	0.0	2.7	0.0	2.8	0.0	0.0	3.0		27.4	0.0	0.0	0.0
3Psc	1997	6022	1997	448	0.0	0.0	0.3	0.3	0.3	0.7	0.0	0.0	4.0		0.0	0.3	0.0
			1998	493	0.0	0.0	0.9	1.5	4.5	1.8	0.6	0.3	13.5		0.7	1.6	0.5
			1999	622	0.4	0.2	1.4	3.5	1.7	1.9	0.0	0.3	8.8		0.0	1.2	0.0
			2000	319	0.4	0.9	0.4	0.0	0.9	0.9	0.0	1.0	7.6		0.0	5.3	0.8
			2001	46	0.0	0.0	3.1	0.0	0.0	3.2	0.0	0.0	0.0		0.0	3.3	5.2
	1998	5808	1998	516	0.0	0.0	0.8	2.8	4.6	1.4	0.0	0.3	1.6		0.0	0.0	0.0
			1999	1189	0.3	0.2	2.4	2.6	2.5	1.6	0.0	0.3	4.7		0.0	0.9	0.0
			2000	635	0.6	0.2	0.7	0.5	0.5	2.3	0.0	0.3	5.8		0.0	1.7	0.8
			2001	101	2.5	0.0	1.4	0.0	2.9	2.9	0.0	0.0	6.4		0.0	1.5	0.0
	1999	4828	1999	677	0.0	0.0	0.8	0.4	0.9	0.7	0.0	0.0	1.2		0.0	0.0	0.0
			2000	909	0.0	0.0	0.3	0.3	0.5	1.1	0.0	0.0	3.4		0.0	0.3	0.0
			2001	126	0.0	0.0	0.0	2.3	2.3	3.5	0.0	0.0	2.5		0.0	4.9	0.0
	2000	6337	2000	672	0.0	0.0	0.0	0.0	0.4	1.3	0.0	0.0	1.9		0.2	0.0	0.0
			2001	388	0.0	0.0	1.1	1.1	2.6	6.8	0.0	0.0	1.2		0.0	2.0	0.0
	2001	6337	2001	145	0.9	0.0	0.0	4.1	0.0	17.2	0.0	0.0	3.3		0.0	0.0	0.0

Cont'd:-

Table 5. Cont'd.

Release area	Year	Number tagged	Recaptures Year	Adjusted total	% of total reported recaptured by area 3K	3LA (Bonavista)	3LB (Trinity)	3LF (Conception)	3LJ (E. Avalon)	3LQ (S. Avalon)	3NO (G. Banks)	3PSA (Burgeo N)	3PSB (Fortune)	3PSC (Placentia)	3PSD (Burgeo S)	3PS_off (offshore)	3Pn-4RS
3Psd	1998	1352	1998	71	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	9.0	20.2	[illegible]	2.1	57.4
				88	1.4	1.6	0.0	0.0	0.0	0.0	0.0	10.8	5.4	11.8	[illegible]	1.7	67.3
				43	3.0	0.0	0.0	0.0	0.0	0.0	0.0	11.2	3.7	6.1	[illegible]	3.6	72.5
				5	0.0	0.0	0.0	28.3	0.0	0.0	0.0	0.0	0.0	25.3	[illegible]	0.0	46.4
	1999	464	1999	44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.5	10.9	20.8	[illegible]	10.4	10.9
				19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	26.7	[illegible]	0.0	24.4
				1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	[illegible]	0.0	0.0
	2001	1665	2001	62	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	2.6	4.2	[illegible]	19.7	50.3
3Psh	1998	1842	1998	34	0.0	0.0	0.0	4.3	0.0	0.0	4.5	0.0	0.0	19.3	0.0	[illegible]	0.0
			1999	33	0.0	0.0	0.0	4.5	4.5	0.0	0.0	0.0	0.0	27.9	0.0	[illegible]	7.3
			2000	21	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	7.7	18.9	0.0	[illegible]	0.0
			2001	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.2	0.0	[illegible]	0.0
	1999	1808	1999	49	2.6	0.0	2.9	2.9	8.8	2.9	6.1	0.0	0.0	36.9	0.0	[illegible]	0.0
			2000	53	0.0	0.0	0.0	5.5	0.0	2.8	2.9	0.0	0.0	22.2	6.0	[illegible]	0.0
			2001	18	0.0	0.0	0.0	7.9	0.0	0.0	0.0	0.0	0.0	42.5	0.0	[illegible]	0.0
	2000	1044	2000	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.2	0.0	0.0	[illegible]	0.0
			2001	12	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	22.3	0.0	[illegible]	0.0
	2001	1144	2001	7	0.0	0.0	19.6	0.0	20.2	0.0	0.0	0.0	0.0	18.1	0.0	[illegible]	0.0

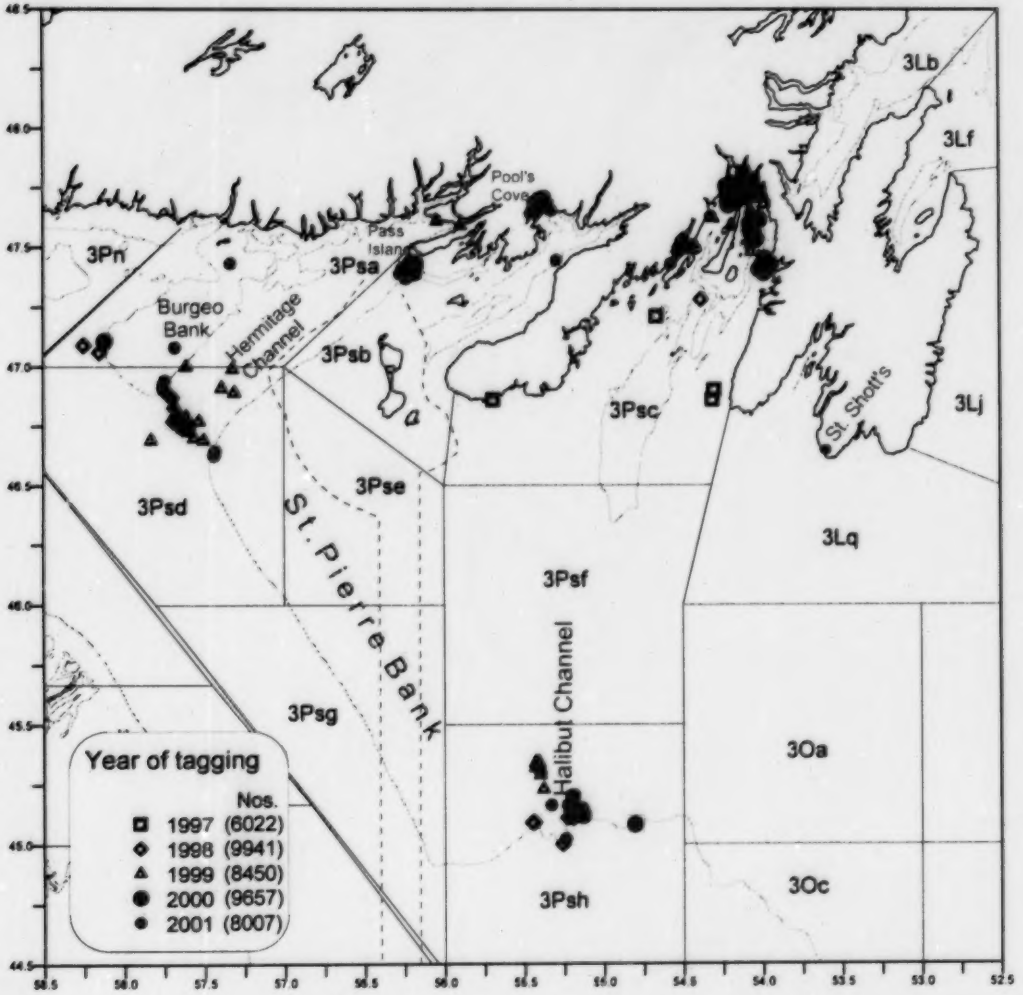
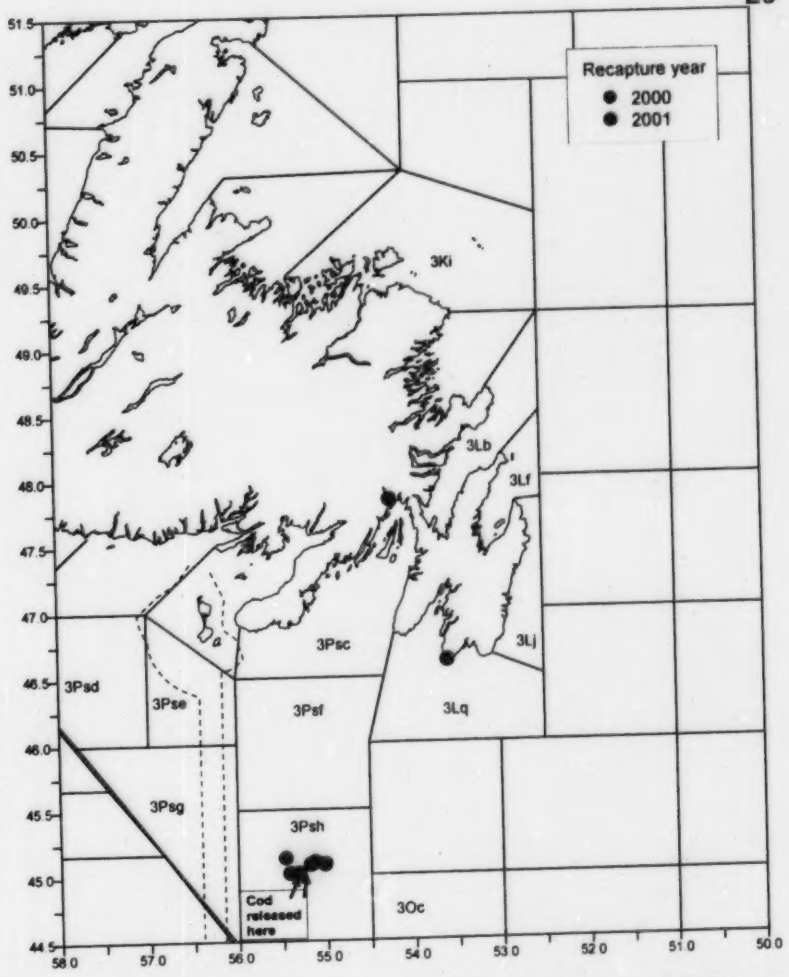
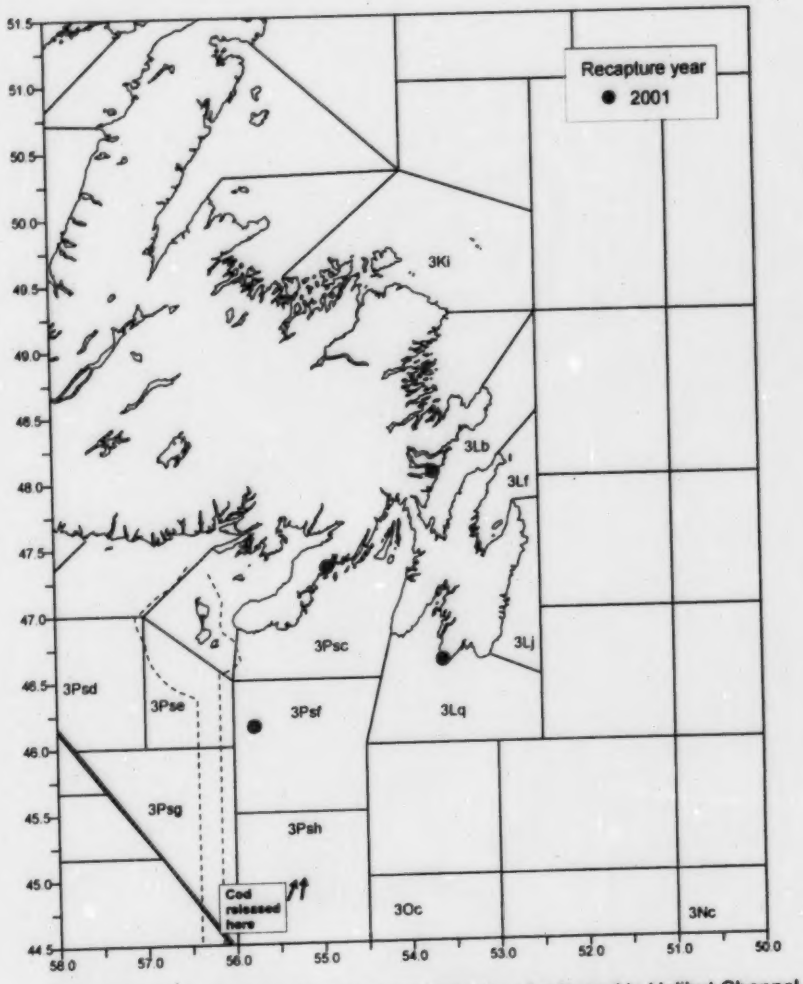


Fig. 1. Locations where cod were tagged, boundaries of unit areas, and total numbers released off southern Newfoundland during April 1997- September 2001.

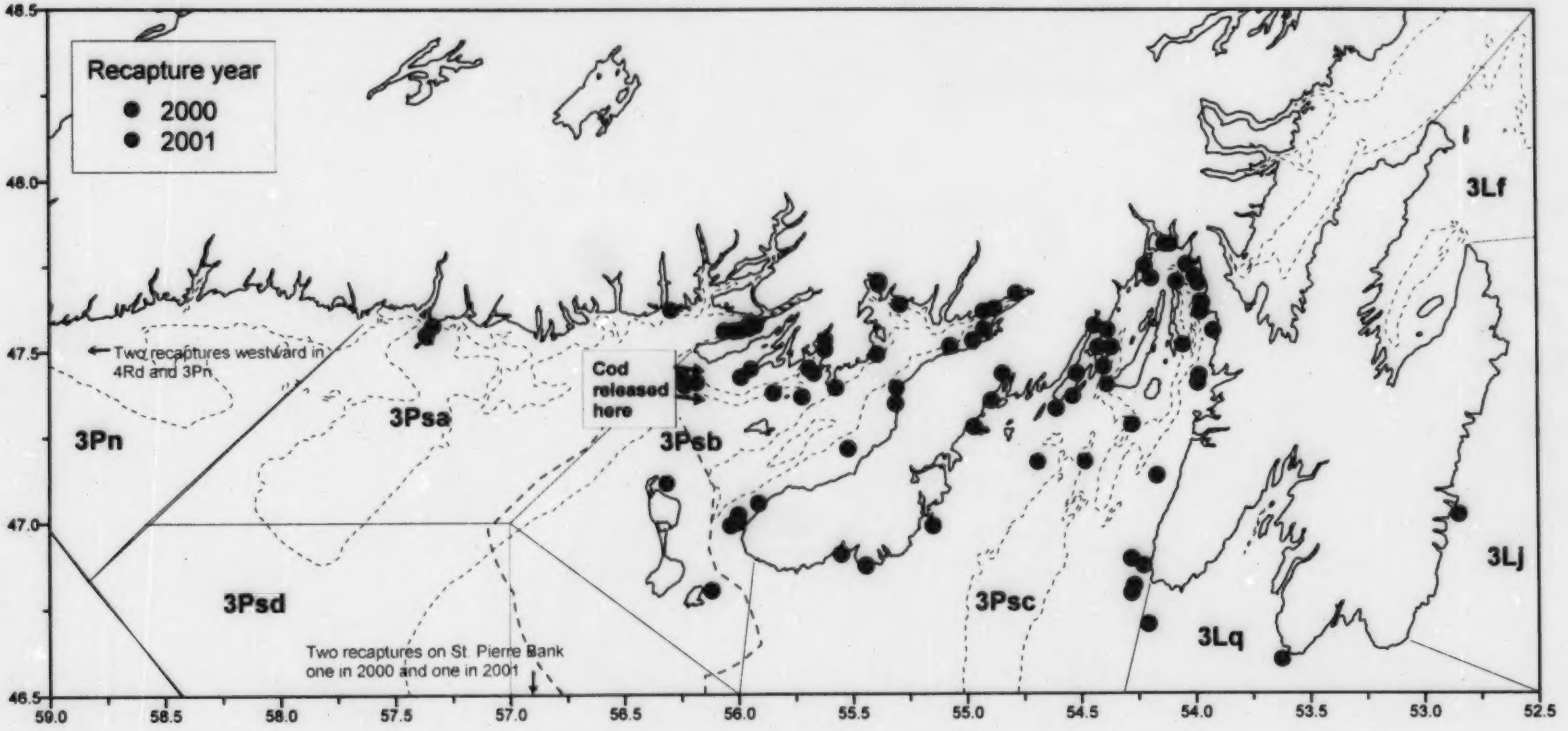


Reported recapture positions (dots) for cod tagged and released in Halibut Channel during 1-7 April 2000 (N=1044).



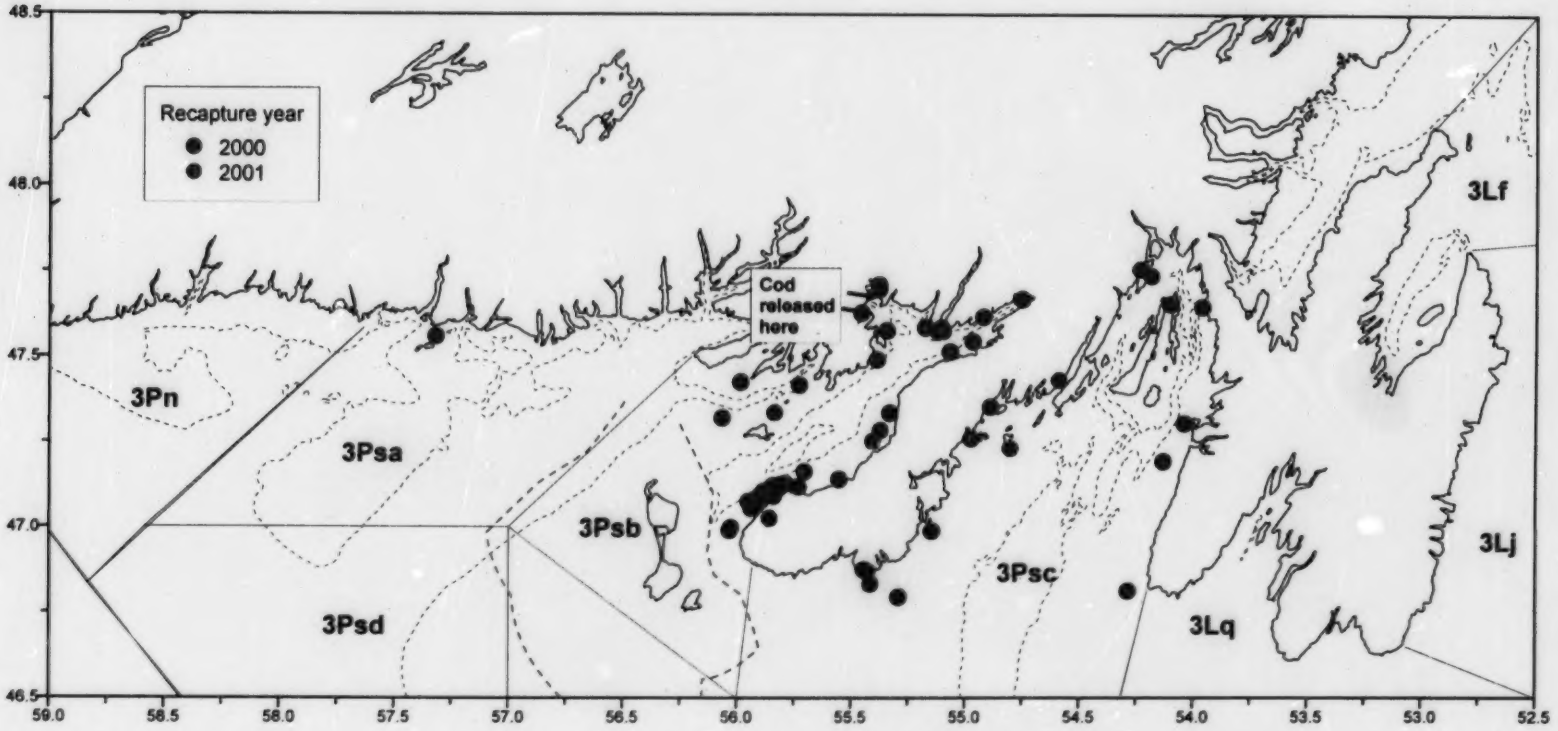
Reported recapture positions (dots) for cod tagged and released in Halibut Channel during 12-14 April 2001 (N=1144).

Fig. 2. Halibut Channel tagging.



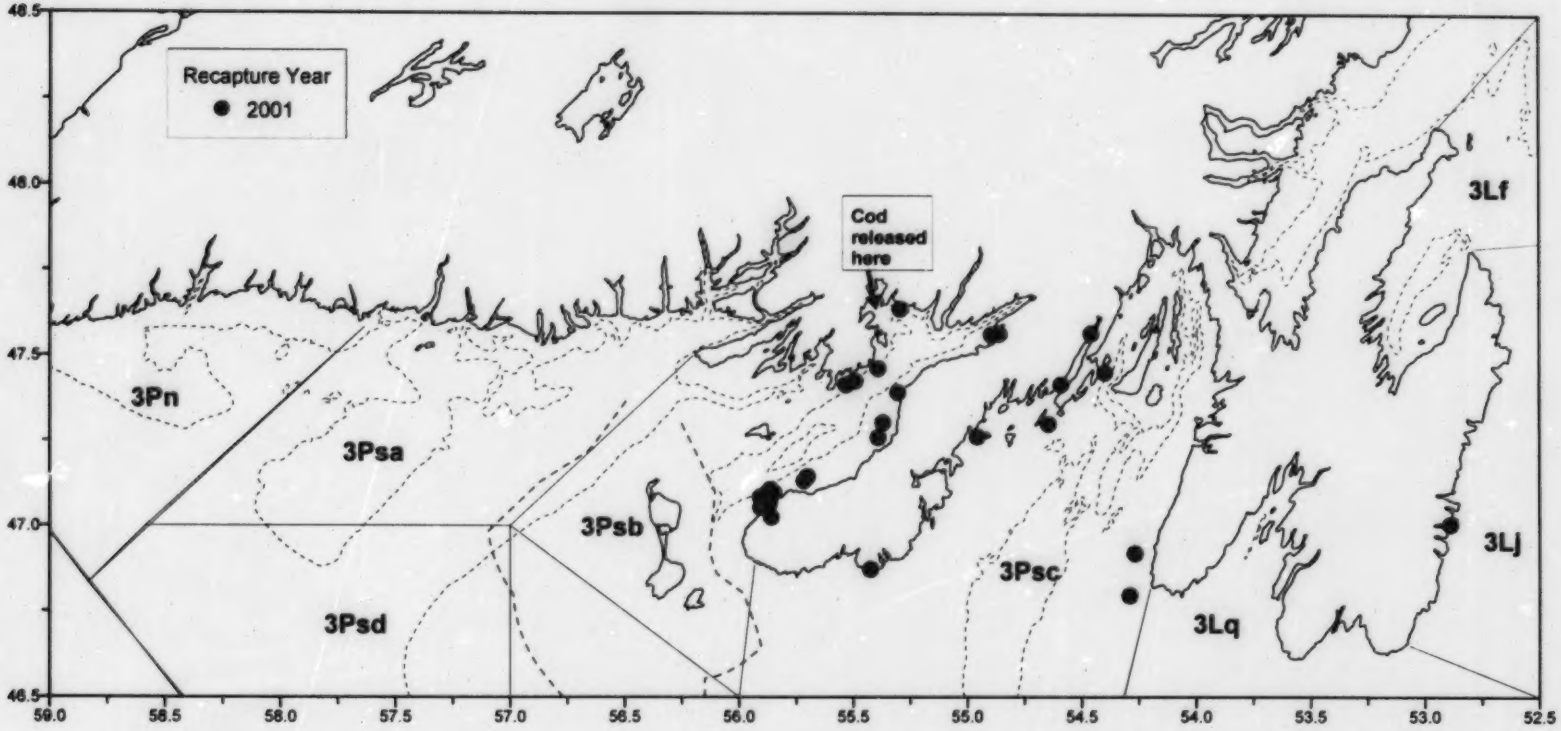
Reported recapture positions (dots) for cod tagged off Pass Island during 5-7 April 2000 (N=1665).

Fig. 3. Pass Island tagging.



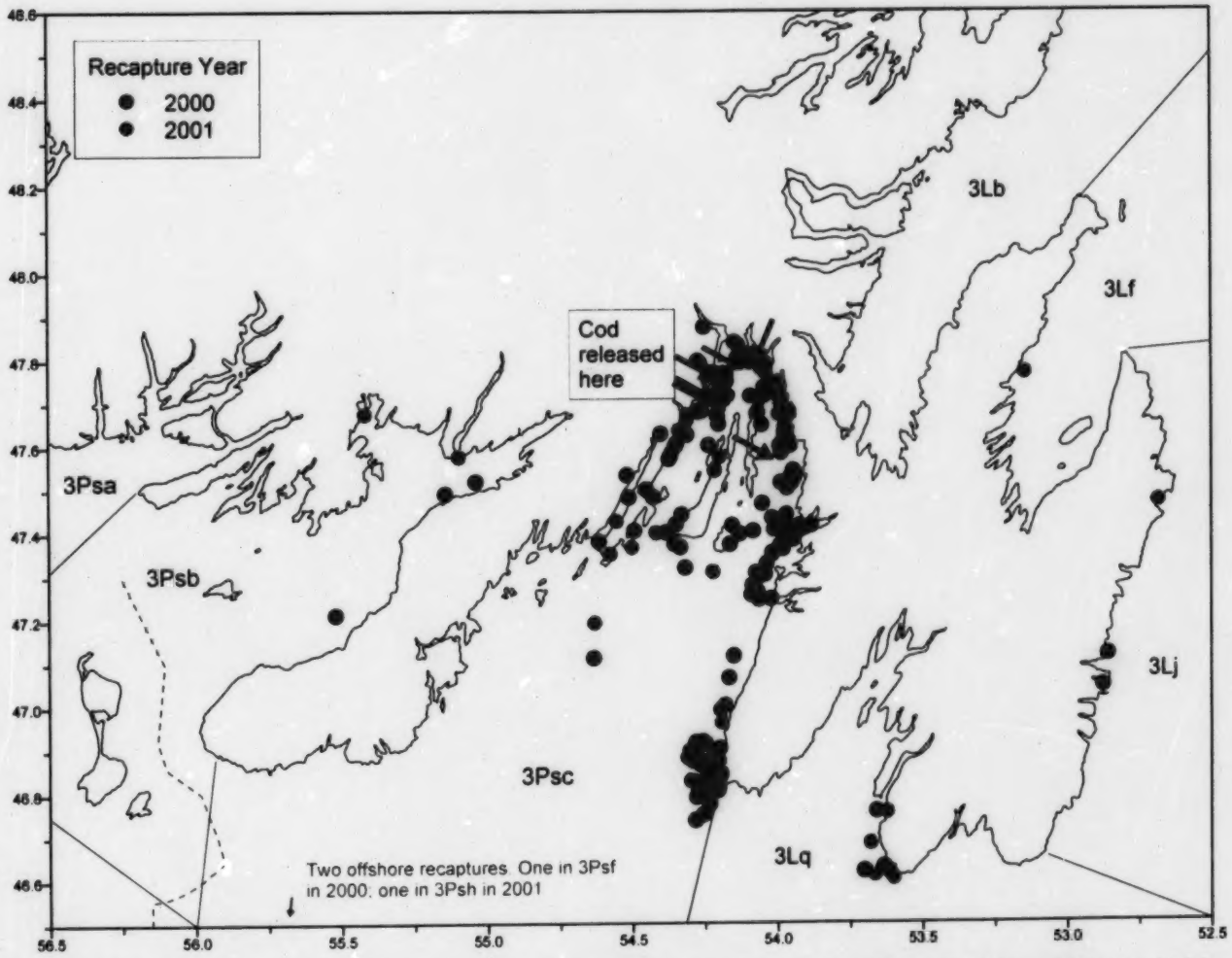
Reported recapture positions (dots) for cod tagged off Pool's Cove during 17-19 April 2000 (N=752).

Fig. 4. Pool's Cove tagging in 2000.



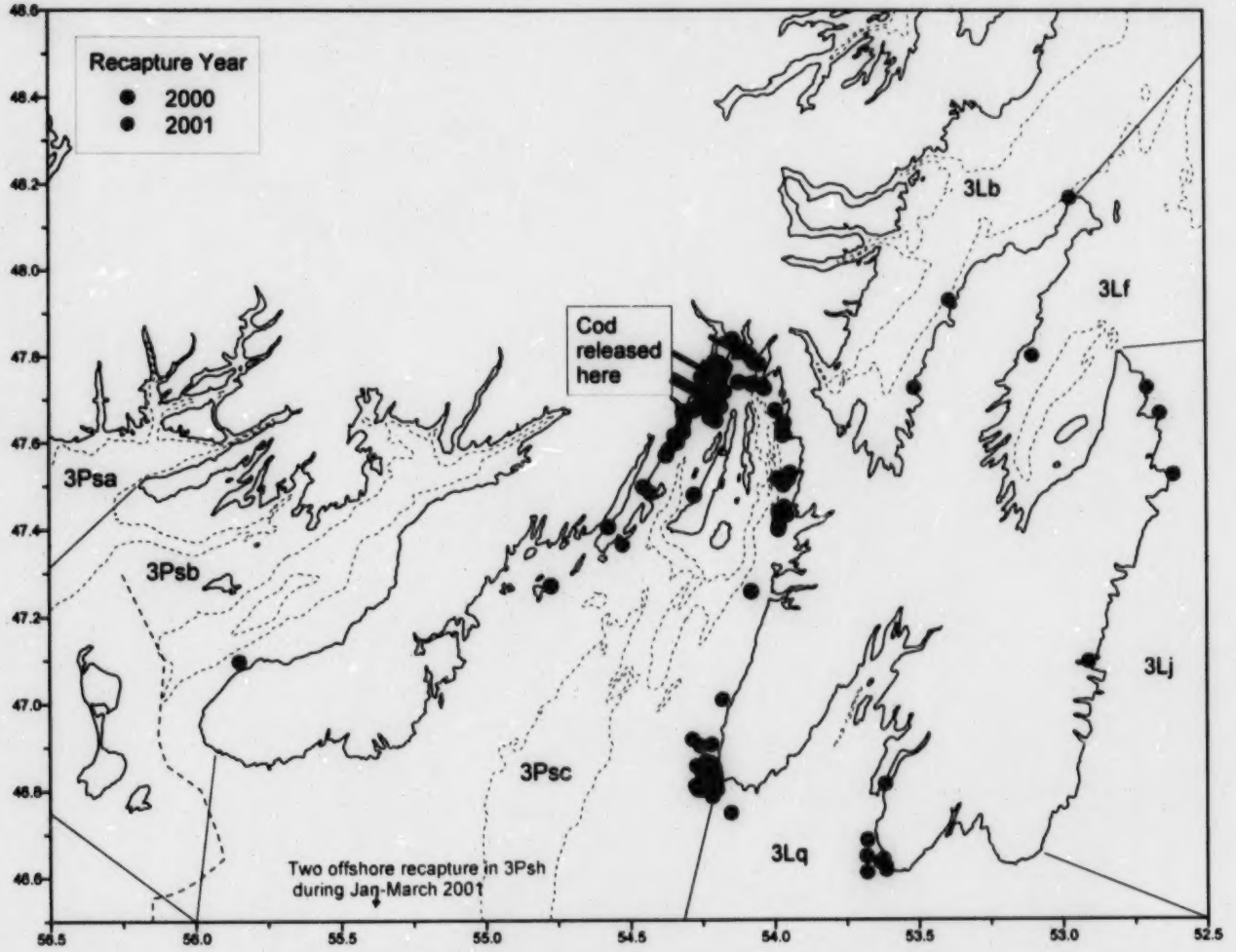
Reported recapture positions (dots) for cod tagged off Pool's Cove, Fortune Bay during 9-11 January 2001 (Number tagged=588).

Fig. 5. Pool's Cove tagging in 2001.



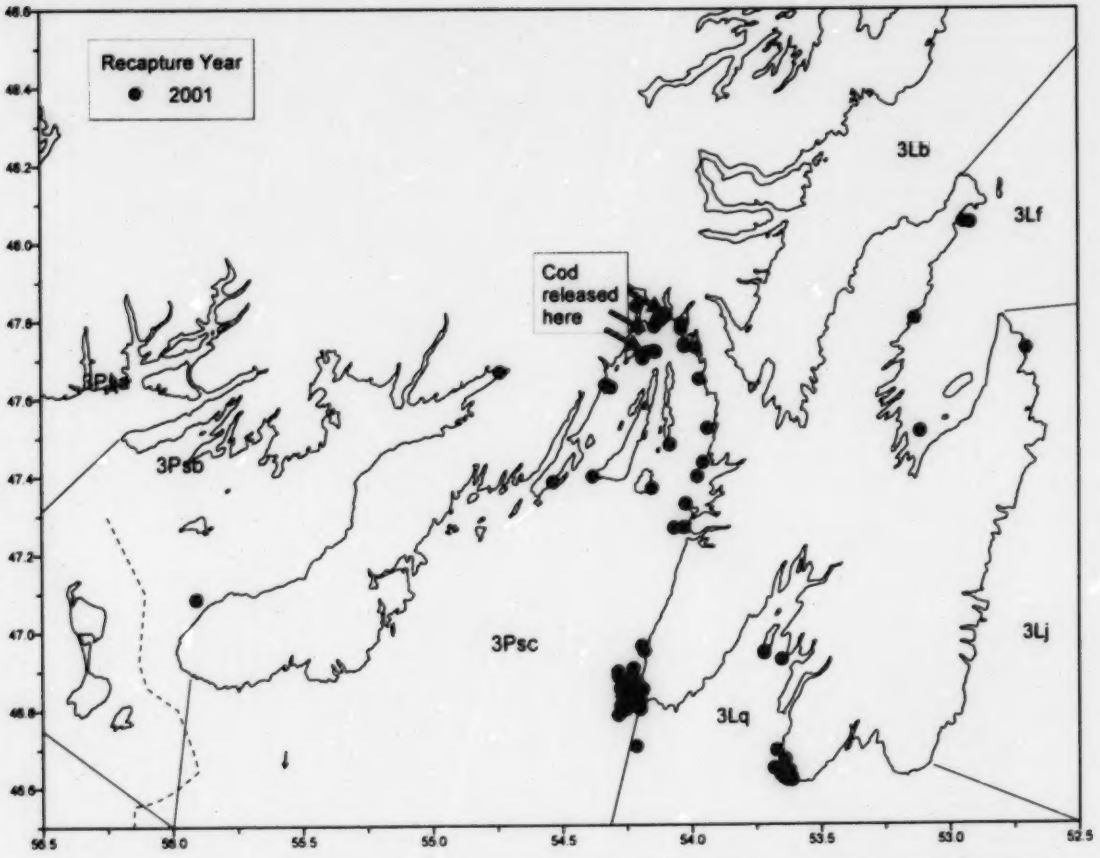
Reported recapture positions for cod tagged at inner Placentia Bay during 26 April-6 May 2000 (N=3022).

Fig. 6. Placentia Bay tagging in spring 2000.



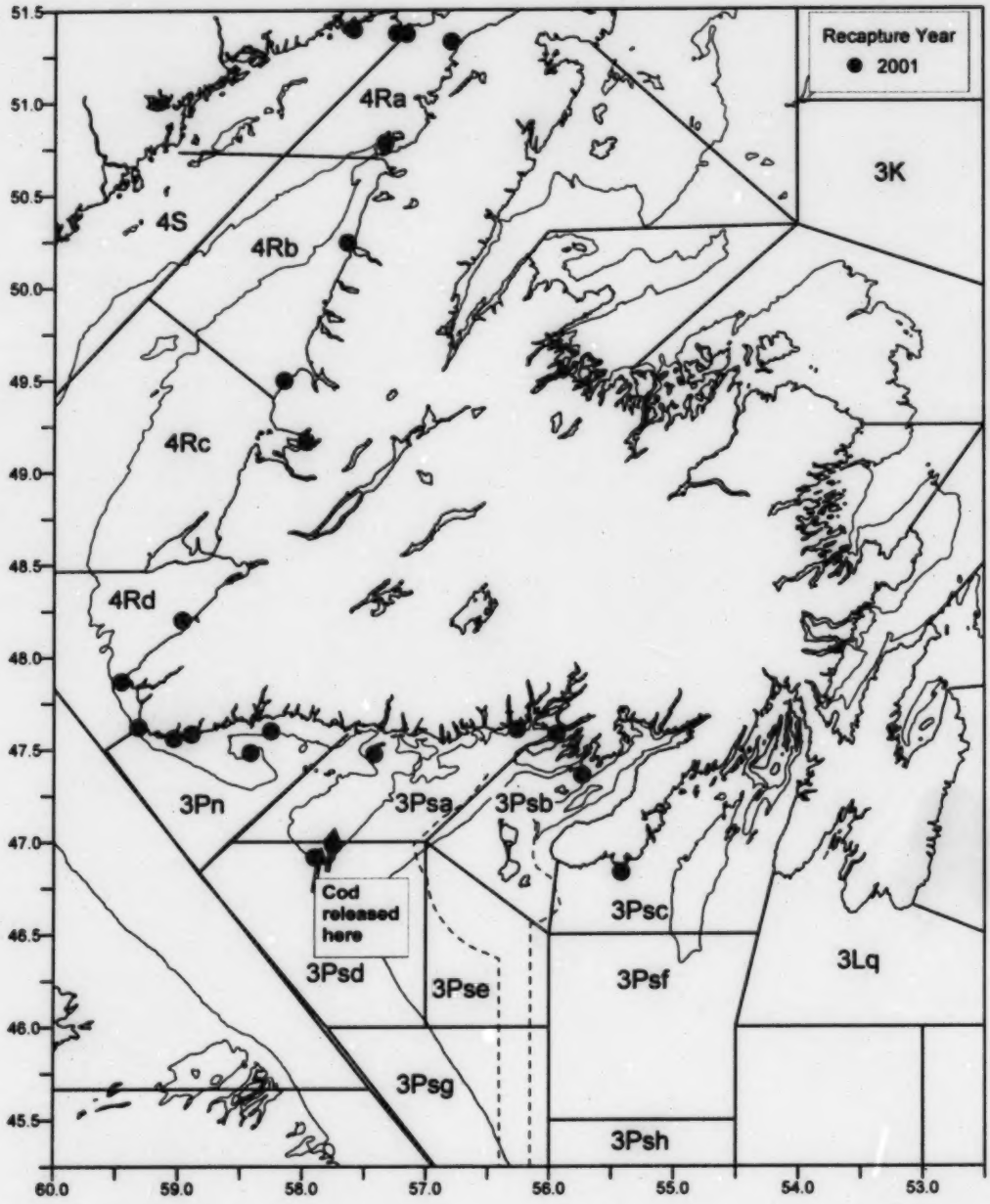
Reported recapture positions for cod tagged in Placentia Bay during 5-15 Nov 2000 (N=3169).

Fig. 7. Placentia Bay tagging in fall 2000.



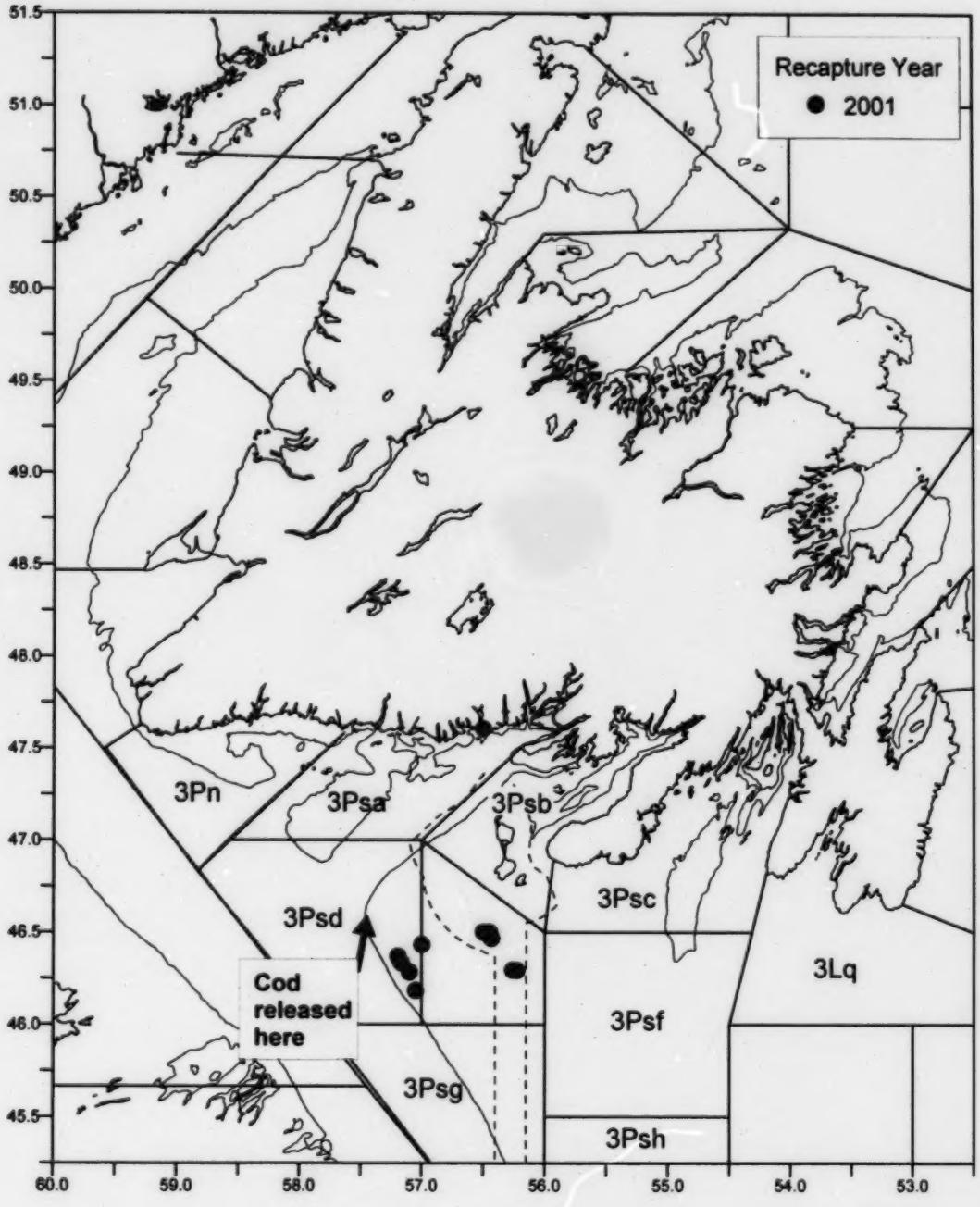
Reported recapture positions for cod tagged in Placentia Bay during 28 April-7 May 2001 (N=3977).

Fig. 8. Placentia Bay tagging in spring 2001.



Reported recapture positions (dots) for cod tagged and released in Burgeo Bank-Hermitage Channel during 15-17 April 2001 (N=999).

Fig. 9. Burgeo Bank-Hermitage Channel tagging in spring 2001.



Reported recapture positions (dots) for cod tagged and released off northwestern St. Pierre Bank during 16-17 April 2001 (N=666).

Fig. 10. Northwestern St. Pierre Bank tagging in 2001.